E/CONF.39/H/5
9 Oct. 1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item : H.1

India

USE OF INTER-INDUSTRIES ANALYSIS IN PLANNING

By Dr. K.S. KRISHNASWAMY

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

4. Papers and summaries will not be available for general distribution in advance of the Conference. They will be published in advance in limited quantities only for the use of delegations of participating governments and of other authorized participants. Post-Conference publication and general distribution of the Conference Proceedings will follow United Nations practices as laid down by the United Nations Publications Board.

Use of inter-industries analysis in planning

by Dr. K. S. Krishnaswamy

I

1. The programming technique used in India so far has in the main been a combination of the aggregative and project approaches. The frame-work for each plan is initially in terms of the social accounting concepts of national income, total investment, import surplus etc., with generalised supply and demand relationships. The operative function in these constructs is of the Harrod-Domar type, elucidating the time-path of national income in terms of assumed or target values of savings-income and capital-output ratios. These coefficients are given values on the basis partly of experience and partly of aspirations. The marginal values of these ratios derived from the arithmetic of the plans constitute, in a manner of speaking, the instrument variables. And note is taken of the qualitative objectives of distributive justice, maintenance of a federal democracy, equality of opportunity and so forth in envisaging possible terminal values of the principal magnitudes.

2. The aggregative frame-work mentioned above is, before the final version of the plan emerges, filled in with a great deal of detail. The line of approach here is via projects or schemes, which are worked out in greater or less detail by State Governments, Central Ministries, public enterprises, private business organizations and so forth. In fitting these schemes into the overall plan, certain allocations of investments and outputs are made for broad sectors such as heavy industry, transport, power, agriculture and social servics. These allocations derive from the changes in production structure considered necessary for accelerating growth. The projects or schemes are then sought to be brought within these allocations, taking into account the more obvious linkages that subsist between them. For some of the basic commodities, the resulting prognostications of supply are checked with demand forecasts based on certain 'norms' of average inputs on the production side or average requirements on the consumption side. The larger of the projects included in the sectoral programmes are assessed separately from the

cost-benefit angle. There is thus a recourse to aggregate models, commodity balancing and project analysis at different stages of plan formulation, as a result of which an investment plan emerges.

3. This process enables the planning authority to set out in considerable detail the physical programmes that correspond to the financial magnitudes incorporated in the macro-plan. But it does not ensure that at all stages of the programme, the product-mix or the investment allocation is in tune with the time-path charted out for the aggregates. In consequence, there is a certain amount of indefiniteness about the intermediate targets(1), which arises not so much from the general element of uncertainty that has to be allowed for in all plans as from inadequate specification of the inter-relationships between sectoral projections. A model which is ab ovo aggregative cannot deal with such inter-relationships for two principal reasons. In the first place, the shape and stability of the total supply and demand functions are immune to variations in the micro-functions and secondly the bulk of the transactions between "industries" (which are not amongst the final users of the national product) are ignored. If one were to speak in terms of equilibrium positions or paths, the attainment of such equilibria by the macro-system is not predicated on equilibrium conditions being satisfied in all the micro-systems.

4. As the production-structure in India becomes more diversified, these features of the national accounting type of macro model render it less adequate as a tool of economic programming. This is because the combinations of sectoral output-changes which could be consistent with a given or desired change in total output increase rapidly in number as the "industries" or "activities" become more variegated. Which of these combinations constitutes the most advantageous one in any particular context of objectives and policy constraints becomes an extremely difficult matter to decide, if the planner has only broad aggregates at his disposal. The articulation of sectoral input-output relationships enhances the scope for informed judgement in this regard, and makes it possible for the planner to take into account changes in product-mix associated with specified patterns of resources allocation. At the same time, since the national accounting relationships can be derived from the input-output matrices, there will be no difficulty in using the traditional aggregative models for the task of linking target variables with policy parameters, structural coefficients and exogenous elements in the systems. Hence the growing interest of India, as of other less developed countries, in inter-industries analysis.

II

5. Like all tools of economic analysis, inter-industry models will have to be based on strong assumptions if they are to serve as programming rather than descriptive devices.

At the very outset, we shall have to assume that the economy can be broken down into "industries", each of which has definable production and demand functions, capable of being used for projection purposes. On the produc tion side, this requires that units or activities having similar input-structures be grouped together, so that a change in their proportionate importance within the "industry" has little effect on the input-coefficients. But this does not necessarily ensure that the products of these units can be considered as perfect or close substitutes from the viewpoint of intermediate or final demand. When these products are needed in the same proportion by other industries, or by final consumers, the physical differences between the commodities do not complicate the demand projections. Indeed, if sufficient care has been exercised in defining the input-structures of all "industries" and if we assume that, with given technology, input-ratios will not change with the size of 'output' of these industries, the multiplicity of products attributable to any one of the industries creates no special problem - at least at the intermediate stage. But as long as the demands of final consumers for different commodities cannot be assumed to move in fixed proportions with a change in total income, it will be difficult to define the demand function for the "product" of an industry with a degree of precision comparable to that of its production function.

6. Because of this difficulty, the temptation is to seek both product-similarity and input-similarity in the definition of "industries". The apparent attraction of this procedure for the planner is that a series of level-constraints may be used for limiting the range of variations on the final demands side and, despite the increase in the number of sectors, operational projections may be worked out for certain specific capital and consumer goods. However, in practice, the gain that may be derived from such detailed categorization of industries is, in so far as projections are concerned, likely to be small. For one thing, the available statistical data may not permit of reliable disaggregation beyond a certain point - when e.g. there is joint production at the micro-level. For another and more important thing, the validity of projections for a sizeable period of time becomes questionable. This is because with an enlargement in the number of separate industries, the production function for each of them becomes so specific that it can be altered by even minor technological changes. The period over which the production functions of all the industries may be considered as remaining reasonably stable becomes very short and consequently any medium or long-term projections derived from them would be subject to serious error.

7. There is in the final analysis no way of eliminating the errors arising from the assumption of "given" technology and one can only seek to minimise them. As mentioned earlier

one way of minimising this error is to confine the projections to very short periods, during which technological change can be assumed to be nil or negligible. But, for the planner in under-developed countries, this relatively easy way of dealing with the problem is not of much use - since his interest generally lies in medium or long-term planning. When the industrial sectors are defined rather broadly, the production functions lose some of their specificity; and it becomes plausible to assume that minor process variations within the individual firms constituting the group can be ignored. More precisely, the presumption is that, over the projection period, such technological changes as occur within the firms in any one industry are not likely to be simultaneous and therefore do not disrupt the aggregative production function. The predictive errors are not eliminated, but are, somewhat intuitively, adjudged to be of relative unimportance to the final outcome.

8. It follows therefore that in order to use the inter-industries technique in working out their programmes, it is not necessary for under-developed countries to resort to a very elaborate break-down of industrial categories. It should also be added rightaway that one should not stop at the other extreme of operating with omnibus categories like agriculture, industry, services and so forth. The point here is that the extent of disaggregation to which each of these broad sectors should be subjected to is a matter to be decided upon by considerations of both statistical convenience and the time-horizon of planning. The need for disaggregation is likely to be greatest in those sectors where the introduction of new techniques or new products constitutes an overt aim of policy. Admittedly, the longer the programming period, the less easy will be the identification of sectors on this criterion. In seeking a workable solution, a great deal of attention will have to be given to the possibility of ordering industries in such a way that the effects of new techniques in one set on the others can be taken into account in successive periods(2).

9. The fact, however, remains that in all programming, whether short-term or long-term, the projections used have to be related to certain normative judgements. These extend not merely to the assigning of weights to individual elements in the social welfare function but also to the measure and type of technological or price changes envisaged. Consequently, whatever the pattern of disaggregation adopted, we cannot dispense with the need for adjustments in the coefficients derived from past data. This is indeed commonsense; but the practical question that arises is : how are these adjustments to be made?

10. The dynamic elements whose influence on the projections have to be explicitly recognised can broadly be grouped under the following headings : (i) technological changes; (ii) differences in gestation lags; (iii) changeability of relative prices; and (iv) effects of growth on behaviouristic parameters. In respect of all of these, their likely effects

of the coefficients of a projection model can only be decided on a more or less ad hoc, empirical basis. There will, of course, be difference in the degree to which each of these adjustments constitutes a hunch. In general, the allowances to be made for technological changes and gestation lags could be decided upon somewhat more objectively than those pertaining to relative prices or behaviouristic patterns. This is because the judgements on input-output relationships or the average gestation lag in an industry can be based on the data obtainable from the most modern units in each industry, or from technological information available in other countries. In using such short-cuts, care will of course have to be taken to ensure that the data borrowed from other countries relate to the technologies which have been, or are being, imported from abroad, and that the derived coefficients constitute a consistent matrix. But the main thing is that there exists a means for making the alterations in technical coefficients dependent on something more solid than the planner's hunch.

11. When we come to anticipating the appropriate change in relative prices or behaviour patterns, no such short-cut exists. The difficulty is compounded by the fact that, unlike the technological frame-work, the economic frame-work within which the price and behavioural adjustments take place is partly expectational and therefore capable of reacting to the very act of programming. This apart, the crucial task involved in this area is that of reducing the consumption and investment decisions of a multiplicity of units to a form which permits of predictive operations. On the consumption side, the major problem is that the consumption elasticities derived from specific budget restrictions cannot be assumed to remain constant with a change in the level or distribution of total income. Since these are, in their turn, affected by the pattern of resource allocation, it follows that all consumption elasticities cannot be taken as fixed, and input-coefficients unilaterally adjusted. If a measure of consistency in the projection is to be attained, one has to allow for the variability of consumption magnitudes, but narrow it down - either by taking small sub-periods for each of which different elasticities might be postulated, or by grouping several commodities in such a way that an Engel curve can be formulated from intertemporal or international data.

12. There is, however, one extenuating factor which should be borne in mind in assessing the difficulties of consumer demand projections. Given the premiss that, in a developing country, keeping the marginal savings-income ratio at a high level will be one of the operational objectives, there is every likelihood of certain autonomous decisions being taken with regard to consumption of commodities which may be regarded as luxuries. Consequently, it is largely in respect of the likely pattern of demand for a limited number of essential consumer goods that projections will have to be made and the output-flows adjusted. It is, of course, possible

that the basket of goods which may be considered essential will be composed differently in different periods. But, if the horizon of planning is not a very distant one, and if the initial income levels are low, the qualitative change in the basket of essential goods may not be appreicable. At relatively low levels of income, therefore, there will be limited scope for variations in the pattern of consumer demand, corresponding to a moderate change in the level of per capita income. In a country like India, for instance, the behaviour pattern of the majority of consumers is unlikely to alter very much in a five-year period, if we assume an annual increase of 3 to 4 per cent in per capita income(3). Over such a range of variation, it would be reasonable to assume that the change in the demand for, say foodstuffs, can be forecast with a fair degree of precision. But as the level of average income increases, and the accumulations of capital and technology enlarge the outputs of a variety of goods, one has to fall back, as in the case of input-coefficients, on the analogy of other countries' experiences.

13. While this may not be entirely satisfactory, it constitutes nevertheless a possible means of working out successive approximations. The problem of taking into account the behaviour pattern on the investment side does not, however, lend itself to similar treatment. This is on the assumption that not all investment-decisions are taken by the Government, and that at least some of the allocations of resources are done through the market mechanism. How the input-output flows will change over time cannot be forecast on the basis of past relationships if the physical and financial conjunctures for the private decision-making unit are very volatile. In practice, the random variations in intermediate demands attributable to this element can be ignored or arbitrarily decided if the private sector in the economy is small, or confined to the production of unessential goods. Where, however, this is not true, neither sophistication in the inter-industries model nor drawing upon international experience for developing hypotheses of empirical invariances will ensure a minimisation of arbitrary judgements in the programme.

14. In other words, the principal advantage of inter-industries analysis lies in the facility it offers for an overt recognition of the structural relationships between a more or less detailed set of physical magnitudes. Since, by and large, this structure can be considered as changing only marginally in relatively short periods, it can be used as a basis for breaking down certain aggregative targets into sectoral targets. But a whole lot of pragmatic judgements will be required in working out the linkages between these targets and the policy instruments appropriate to different stages of the programme. This is particularly true in formulating an operative programme for a mixed economy. And finally, the longer the time-horizon for planning, the greater will be the need for programming in terms of broad industrial groups.

III

15. As mentioned at the outset, explicit inter-industries models have not yet been utilised in India for working out the five-year plans. Attempts have, however, been made - principally by the Indian Statistical Institute - to construct input-output tables for certain years from data obtainable within the country. The first of these tables was a transactions-matrix for 1950-51, with a twelve-sector break-down, supported by capital stock and import matrices. The sectors chosen were rather broad and arbitrary - such as large-scale producers goods, large-scale consumers goods, small-scale enterprises, agriculture and so forth. They also included two household sectors - urban and rural. The primitive character of the exercise was due to the extremely limited body of statistical data that was available at that time. Despite this, the preparation of this table constituted an important first step and served to enlarge the interest of both technicians and Government in this field of research.

16. Transactions tables with a 36 x 36 break-down were subsequently prepared for the years 1951-52 and 1953-54. The sector classifications in these tables were much more rational, in the sense that as much consideration as possible was given to disaggregation on the basis of similarity in input-requirements. However, the distinction between small-scale and large-scale industries was maintained - again for reasons largely of statistical convenience(4). The tables were built column by column through an analysis of the cost data of various industries. Adjustments were then made for distributive margins, import content and so forth, in order to knit the rows and columns, for outputs valued at market prices. On the final demand side, a seven-fold break-down - household consumption, public authorities' current outlays, Government capital outlays, other capital installations, exports, imports and net inventory changes - was adopted. But a good part of these estimates had a poor basis of primary data and involved the use of approximate distribution of residual quantities.

17. The pattern set in the 1953-54 table has been adopted for those constructed for 1955-56. The transactions-matrix for 1955-56, which was originally of the rank 36 x 36, has very recently been enlarged into a 48 x 48 matrix, by disaggregating some of the manufacturing industry sectors included in the original table. In addition, the primary inputs have been further elaborated with a view to distinguishing between the different sizes and types of wage income generated in the several sectors. There has as yet been no capital coefficients matrix supplementing this current-flows table. It is, however, hoped that in the next few months, the current as well as capital coefficients matrices consistent with this input-output table will be developed and used for trial projections for 1960-61, which may be checked with actuals.

18. Alongside of this, work on a somewhat more elaborate transactions-matrix has been initiated in the Planning Commission, in collaboration with the Central Statistical Organisation and various Government Ministries. A ninetyfive-sector classification of the economy has been prepared, largely on the basis of input-structures. The data being used for the construction of this table relate to the period 1959-60, and the objective is to present the transactions-flows at producers' prices. The project also involves the articulation of a capital coefficients matrix with the help of both cross-section and cross-country data. It is anticipated that by the time these matrices are ready, the trial projections based on the 1955-56 table will have been carried out, and a clearer idea obtained of the analytical model for further projections.

19. This in brief is the Indian experience in the construction of inter-industry tables so far. As regards the use that has been made of the existing input-output tables, nothing very definite can be said. Undoubtedly, some of the input-output relationships thrown up by this work has influenced the long-term projections made by the Planning Commission for identifying some of the output targets. However, much of this has been in the form of isolated projections, with no more than a rough balancing of anticipated supplies and demands. One reason for this has been the lack of uniformity between the sector classifications adopted for inter-industry tables and the classifications adopted for planning or administrative decisions. This is being sought to be remedied in the later input-output constructs. But apart from this minor matter, many of the difficulties referred to in Section II, regarding the use of inter-industry matrices for projection purposes, are present in India. Despite the rapid increase in the variety of statistical data, it will be some time before a proper ground-work can be laid -both for reliable inter-industry flow matrices and for estimation of plausible behaviouristic parameters. More than anything else, there is no body of reliable information relating to final demands of the household sector, or to the investment activities of a large part of the private sector.

20. While these gaps exist, it is clearly unrealistic to expect programming on the basis of an elaborate input-output model. However, it is equally unrealistic to ignore the possibility of applying this technique for a better enunciation of the programme for a limited range of sectors. As it happens, the priority sectors in India's five-year plans are, apart from agriculture, mainly capital or intermediate goods industries, in respect of which Government rather than the market decides the basic issues. These industries are, further closely interrelated and most liable to experience the impact of modern technology in the immediate future. It is also not difficult to adjust for the likely technological changes in these sectors - partly because of the gestation lags involved, and

partly because of the system of tied credits through which their foreign exchange expenditure is met. Under these circumstances, it seems not only possible but necessary to treat these kay sectors as forming a sub-matrix, with definable current as well as capital transactions. Initially, therefore, we may treat this sub-matrix as the operational part and derive projections upon the assumption that the bulk of random variations lie outside this set. Progressively, the rank of this sub-matrix can be raised, as the production structure becomes more diversified and the statistical bases for estimation become stronger. This is undoubtedly a cumbersome approach, in which there are no automatic checks for general consistency or for optimality. But in the present state of our knowledge of the structure of the Indian economy, and of producers' or consumers' reactions to changes in incomes, prices, taxation and so forth, there seems to be no real alternative to it.

Note:

(1) The targets referred to here are "intermediate" in a temporal as well as a technological sense; they are functions not merely of the time-horizon and the terminal growth-rate envisaged but of the final bill of goods and the technological processes involved in producing them.

(2) If we arrange industries in decomposable groups, so that there is a one-way connection as we go down the numbered categories, it is possible to consider all technological changes within a period as occurring in industries below a certain number. The effects of these can be carried forward to the industries buying their inputs from this group in the subsequent period, and so forth. This involves, however, defining the period in a special way - in terms of the lag between the innovation-decisions in one group and the innovation-decisions in another.

(3) This is obviously tenable only when there is no major shift in income-distribution over the five-year period, in favour of the low-income groups.

(4) Apart from this, the special role accorded to development of small-scale industries in India's five-year plans might also be considered as responsible for this differentiation.